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Industrial Pointers in Tamil Nadu

One of the eleven central sector undertakings in the state, the High Pressure Boiler Plant in Tiruverambur, Tiruchirapalli run by the Bharat Heavy Electricals Limited is to be considerably expanded and a new dimension introduced in the development of thermal power technology and the design of thermal power equipment. Started with Czech collaboration six years ago, the plant has reached a level of production and expertise which has led to an agreement with the United States Combustion Engineering, the first of its kind in our public sector and among the foremost in steam and nuclear equipment. The Tiruverambur plant's operation in power station and industrial boilers at the level of Rs. 200 crores is an effective and economic import substitution programme.

Along such lines, despite inadequate natural resources and industrial raw materials, industrial output is currently contributing to around 22 per cent of Tamil Nadu's total production. This represents an 80 per cent increase since 1950 when a planned programme of industrialisation of large scale manufacturing, small enterprises, mining and quarrying, electricity and construction was initiated. The growth rate in industrial production in the state is still well below the All-India target of 7 to 8 per cent. In 1969 it was 4.5 per cent over that of 1968. A review of the performance of the major industrial components in 1970 has led the National Council of Applied Economic Research to conclude that it will be optimistic to expect more than a 6 per cent increase in All-India industrial production, which added Rs. 125

thousand crores to the production total for the year. The Tamil Nadu report on industrial performance for 1970 will be placed this month on the table of the newly elected Assembly.

It will call for a comparative analysis of eleven elements: total production, twenty-two public sector undertakings, the twenty-nine groups of private sector performance together with the new licenses issued, the Tamil Nadu Textile Corporation, financing by the four institutions [Industrial Finance Corporation (IFC) Industrial Development Bank (IDB) Industrial Credit and Investment Corporation (ICIC), and the Madras Industrial Investment Corporation (MIIO)], mining and minerals, small scale industry, industrial estates, rural industries and handicrafts, industrial power consumption, dispersal and decentralisation and the manpower profile.

The three all India financing institutions referred to above IFC, IDB, ICIC, have since their start provided Rs. 946 crores to industrial establishments in the seventeen states and union territories. Next to those in Maharashtra, industries in Tamil Nadu have received the largest share of such aid amounting to Rs. 119 crores. In order to retain her place in the industrial financing map, the state must not only continue to rely on its comparative entrepreneurial and infrastructural advantages but forge ahead in new directions such as: locating industries in the backward districts of the state, which now has an All-India priority, pushing forward with non-traditional industries including fertilisers, chemicals, paper and cement which attract loans and guarantees from IFC or ICIC and refinancing facilities from IDB. A special incentives programme is proposed for nine districts selected by the Planning Commission: South Arcot, Tiruchirapally, Madurai, Ramanathapuram, Kanyakumari, Tanjavoor, Dharmapuri and North Arcot. Another area which should be

further developed in the state is industrial co-operatives, particularly for our languishing textile industry.

The Salem Steel Plant which ought to be in the 1970 balance-sheet is behind schedule for reasons referred to in the last issue of the bulletin. There is a further reason in the unexecuted topographical survey of the area which must precede operations. The topographical survey has to be undertaken by the Survey of India whose action is held up through internal paper work among four authorities—the Union Ministry of Steel and Heavy Engineering which must authorise the Survey, the Union Ministry of Education and Youth Services which must grant priority for this work to its constituent department, the State Government which must see clearly the need for this important activity and some loosening of the secrecy which surrounds the maps of the Survey of India. The parties should now join hands in rapidly completing this essential precondition for this priority project.

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Agriculture in the State

As part of the high agricultural yields, the prizes for the best farm output for 1968-69 have now been awarded. T. Narayanaswami of Mettupalayam won the paddy competition with an output of 5517 kgs. per acre using 1R-8. M. K. Gopal won the cholam competition with 2586 kgs. per acre with CH-31. Janardanan of Singanallur was awarded the Ragi competition with 2371 kgs. per acre using CO-1 and 2. These results are a useful pointer for the break through in cereal production that is being readied in the state. One such achievement is in the 1970 bumper coffee crop which has attained an all time high of 82 thousand tonnes. This will ensure an export of over 35 thousand tonnes and a buffer of

6 thousand. The cotton position however continues to be a difficult one.

One of the most important pointers to the future of agriculture in the state is the programme which has just been launched, aimed at the small farmers who constitute over 80 per cent of the total farming community, through the Small Farmers Development Agency. The Agency is being formed in three districts, South Arcot, Madurai and Tirunelveli. It will operate a Rs. 31 crore programme of improved seeds, fertilisers, water and credit to help boost production by small farmers over a four year period. The programme starts with twenty panchayat unions in the three districts this year and will extend to forty-one next year. It is entirely financed by the Union Government as part of an open ended Central Scheme to turn attention to the hitherto neglected sector—the small and eventually the dry farmer. In Tamil Nadu the programme will be supervised by a state committee chaired by the Chief Minister. It is the coordinating work in each district of some seven district agencies including the Land Development Bank, the Co-operative Bank, the Commercial Banks, etc., under the chairmanship of the District Collector which will ensure the effective and successful execution of this important project.

There is in this and its successor programme a rather important and somewhat new function for the Commercial Banks in the state. The banks can usefully build up valuable experience in opening rapidly rural branches on which they have made an encouraging start since nationalisation. Against the Fourth Plan target of 450 branches, the first year record of over 95 centres is encouraging. They can, not only meet the medium and short term credit needs of the small and dry farmer; they can also improve the quality of rural loan finance through their supervision of disbursements and end use. Above all they

should turn their rural branches from the past tradition of acting simply as deposit centres into becoming the focus for rural loans and credits. In the past these centres used to collect the rural resources and act as transmission belts to the Madras money market. This should now be reversed. Under such conditions, Small Farmers Development Agencies can also be established in other needy districts in the state and can in time function independently of central financial support.

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Education in the State

Apart from the agricultural education institutions which are now to become the Agricultural University, to which reference was made in the March issue of the bulletin, Coimbatore is a major educational centre in Tamil Nadu. The State Government and two large educational trusts, PSG and Sri Avinashilingam are the major educational sponsors in the city. The Sri Avinashilingam Home Science College, which is the foremost of its kind in South Asia offers a wide ranging and effective under-graduate, teachers, masters and doctorate programme in Home Science. 483 graduates and post graduates in Home Science from all over India as well as from some Asian and African countries, will be leaving the Institution this year to serve in one of the most strategic areas of development, nutrition. The Dandekar and other studies of Indian poverty have amply demonstrated the serious inroads which starvation and malnutrition are making on 50 per cent of our rural and urban peoples and on a much larger and frightening percentage of the pre-school child. We are in real danger of producing a future generation of idiots. The college is at the forefront of an action research programme which is aimed at a balanced school meal with local food grains costing 12 to 15 paise, and a

fortified cereal supplement again made up of local foods for the pre-school child. This demonstration has shown that a nutrition programme for this key group of the pre-school and school child is both feasible in financial terms and possible in terms of *acceptation and motivation*. What is next needed is an institutional frame work at the Panchayat, District, State and Central level which will mesh the resources and expertise of the Agriculture, Health, Education, Rural Development and Local Administration Authorities. The setting up at the centre of such a committee to deal with the problems of the child should now be extended down through the Panchayat level.

The other educational complex in Coimbatore is the Ramakrishna Mission Vidyalaya catering to 3 thousand students served by 150 staff covering a Rural Higher Education Institute, specialising in rural co-operatives, a School of agriculture and a School of engineering, an Industrial Institute whose training programme is centred in the production of agricultural motor pumps and automotive machinery, a College of physical education, an Arts and Science College and a Teacher Training College. These institutions are involved in rural development and research. One of the research projects of the Teacher Training College throws interesting light on the speed of reading of the school child in the state:

WORDS READ PER MINUTE

	Rural Child	*Urban Child*	*U.S. Child*
I	—	—	55
II	20	36	90
III	39	50	115
IV	40	57	168
V	65	77	190

The need for more competent teaching and techniques to promote reading ability particularly of the rural child of the state stands out starkly in this table.

Reorientation of technical education, particularly for diploma courses for technicians has been strongly recommended at a National Seminar held last month at the Indian Institute of Technology, Guindy. Such restructuring should include diversification of diploma courses to meet the increasing demand for technicians with greater depth of skills, practical training in industry through sandwich courses and an extension of the Industrial Apprentices Training Act to include diploma holders, a well synthesized teacher training programme bringing together technical, industrial and educational methodologies and a continuing man power assessment to act as a feed back into the technical education system. An Educational Development Centre to co-ordinate the various curriculum development initiatives, an expanded management education and training programme based on a survey of management man power needs are further timely recommendations. The same cannot be said for the suggestion for a Technical University in each state to which all Engineering Colleges will be affiliated. Such a structure could militate against the unity and the interaction of the component parts of the educational system—which is a system in its integral totality. Prof. Hegde in the accompanying article makes a case for such a University as part of a University system and as part of a few peaks in the academic plateau.

The Madras University Academic Council's recommendation at its March meeting for diploma courses in Industrial Engineering and a Bachelor of Science Course in Applied Engineering seems to move in the direction of the restructuration recommended and will in time close the current gap in the supply of middle level technical personnel needed by our grow-

ing technological and industrial establishments in the state.

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Census

March saw the start of the decennial census operations for the country and the state. 65 thousand enumerators, 18 thousand supervisors and 25 officers started work on March 10th in the state, visiting each household, seeking answers to demographic and biographic details including age, sex, birth-place, educational level, marital status, religion, occupation, etc. This census which is rightly described as the largest, most demanding and most expansive in the world will come to a close on March 28th. On April 1st there will be revisional rounds to make adjustments and cross check the resulting totals. The first report in mid April on Tamil Nadu's population facts and demographic trends will provide information on size, sex and rural-urban distribution, work participation ratio, literary rates, work classification, etc.

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Progress Report on Arrangements for the Summer Workshop

The workshop on research methodology in economics will be held in Madras Christian College, Tambaram from May 3rd to June 12th. Progress in organising the workshop to date is given under:

Participants: The following Ph.D. students and staff supervisors have been so far nominated by their universities:

Karnataka University, Mysore	..	5
Sri Venkateswara University, Andhra Pradesh	..	3
Mysore University, Mysore	..	1
Andhra University, Waltair	....	**3**
Kerala University, Trivandrum	....	**5**
Madras University, Madras		2

Annamalai University, Annamalai Nagar .. 1
Madurai University, Madurai .. 2

Resource Personnel who have so far accepted the invitation are:

Dr. C. T. Kurien, Professor of Economic, Madras Christian College, Tambaram—*Director.*

Dr. K. Krishnamurthy, Senior Fellow, Institute of Economic Growth, Delhi.

Dr. N. S. Iyengar, Professor of Economics, Osmania University, Hyderabad.

Dr. S. K. Bhattacharyya, Professor of Economics, Calcutta University, Calcutta.

Dr. K. N. Raj, Professor of Economics. Delhi University, Delhi.

Position Papers:

The following have agreed to prepare basic papers for the workshop:

What is Economic Research? : Dr. Ahuja, Director of Research, Indian Institute of Public Opinion, New Delhi.

Identification of a Research Problem: Dr. P. R. Bhrahmananda, Professor of Economics, Bombay.

Target Setting, Forecasting and Predicting: Dr. Pitambar Pant, Planning Commission, New Delhi.

Use of National Sample Survey and Census: Dr. Panikar, Professor of Economics, Kerala University, Trivandrum.

Historical Method: Dr. Shanmugasundaram, Professor of Economics, Madras.

Research Design and Typology: Dr. G. Mathur, Professor of Economics, Osmania University, Hyderabad.

On Model Building two papers are available:

Towards a Post War Econometric Model of India by Dr. K. Krishnamurthy, Institute of Economic Growth, Delhi.

What kind of Macro Econometric Model for Developing Economies? by Dr. L. R. Klein, Philadelphia University.

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March Madras Development Seminar

The March Seminar was led by the Principal K. S. Hegde of the Engineering College, Guindy on the subject 'Innovation in Tamil Nadu Education'. His paper forms the main article in this issue of the bulletin.

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A Second Article

A Second Article on "Science and National Development" also appears in this issue.

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INNOVATION IN TAMIL NADU EDUCATION.

By

K. S. HEGDE

Principal, College of Engineering, Guindy. Madras.

1.1. Next to food and shelter, what is universally sought by man is good education for the young. Modern states have come to accept universal education for its people as a basic obligation that they have to carry out. A literate and educated citizen is considered to be the pillar of our social structure, whatever be the structure of the governmental organisation. In the present day world, there is a direct relationship between the level of education a person has received and opportunities for a good life that are available to him. There is thus a demand, for more and more education, by more and more people. Education has become one of the most massive corporate efforts of modern societies. It is by education and training that we equip our young to face the tasks and challenges of the adult world of tomorrow. We would be guilty of a serious breach of faith with posterity if we did not give of the best of training we are in a position to command, to our young because it is a universal aspiration that the generation to follow us will build well upon the foundations laid before, improve, innovate and ennoble all human institutions and its cultural and artistic heritage.

1.2. Obviously, it is not enough to be aware of the importance of education. We must be aware of its

meaning and purpose, its objectives and mechanics, because only with such clear understanding will we be able to decide what would be a good and worthwhile education that we should offer to our young and how we should organise and offer it so that the social values and institutions that we hold dear are not eroded or submerged in an avalanche of unreasoned and disorganised mass of information or skills. No country can long survive if all its people are trained only as very skilled surgeons or only as scholarly historians. The education and training must bear a relationship to our social needs just as it must have a relationship to the aptitudes and inclinations of the young who are being educated. Not very long ago, we used to speak loftily of education for education's sake. We assumed that the only purpose and meaning of education was to let a young mind flower to its natural potential; learn the few basic skills needed to acquire information, culture and pleasure on its own. In other words, teach a young one to read and write, to reason and argue, to relish poetry and savour philosophy, to think of beauty and truth. It used to be said that the purpose of education was to draw out the vast potentialities of the mind, to concentrate on the training of the intellect, to let the human mind flower freely. These concepts have undergone vast changes in the past few decades, and I suspect that part of the reason for such change, is the growth and development of technology, that has pervaded man's life so extensively. The second reason is the changing of concept of governmental organisation that have been accepted extensively which places a lot more importance on fulfilling man's primary needs of food, clothing and shelter whether or not his intellectual needs are fully met. Functional, need-based, job-oriented education has, therefore, been emphasised lately more and more because finding employment in a highly complex technological society needs a lot more education (or training if one

would prefer this term) than would have been the case otherwise. Education and training have thus become indistinguishable terms, in the present context. Most educational institutions today, would prefer to claim that they train their students for the opportunity and challenges that the world of today provides rather than educating them only to seek comfort and solace in their own ivory towers.

1.3. From the very earliest of times, the major constituent of education has been an attempt on the part of society to train its young to conform to the values and norms that are accepted by society. For example, in a democratic society, the young are taught that individual liberty, freedom of choice etc. are sacrosanct, and should be preserved as a very valuable heritage. In a communist country, the emphasis shifts and collective welfare and good, even at the sacrifice of individual freedom and happiness, becomes the ideal that the young are expected to accept. Perhaps, in a country that has accepted a particular religion, the teachings of that religion become a vital part of the educational content. In all countries, it must be admitted, that a certain amount of national pride and even implied sense of superiority is generally an accepted part of the content of what the young learn to the detriment of the very laudable idea of the equality and brotherhood of man.

1.4. We in this country have accepted a democratic way of life. The insistence is on equality of all men and equal opportunities for all. Freedom of the individual, as long as it does not infringe on the rights and opportunities of others, is also part of our accepted way of life. Within this frame-work, our educational effort has to deal with what only a few decades ago was a very conservative and tradition-bound society subjected to other ills of poverty, ignorance and prejudices. The value and role of modern education in the rapid transformation of such

a society for fulfilling the aspirations of our people cannot be over-emphasised.

2.1. The educational objective that we have placed before ourselves is free and compulsory education to be provided to all young people up to the age of 16-17 years, *i.e.*, generally up to the secondary school. On one side we are aspiring to ensure 100 per cent literacy amongst our people. On the other side, the attempt is to equip all our people with necessary levels of intellectual and physical skills that will enable them to be useful members of society, contributing to its growth and a better standard of living for all people.

2.2. The present position of the progress of education in Tamil Nadu is quite encouraging but is not anywhere near the realisation of the objective of universal compulsory education for all children. Nor have we been able to ensure full literacy amongst the people. It is estimated that there are about 70 lakhs of children enrolled in about 34,000 educational institutions of all kinds. The large majority of these are, of course, elementary schools, of which there are 31, 706 with an enrolment of 62,95,000 children accounting for about 93% of the children in this age group. The 2,541 secondary schools cater to about 6,68,000 children representing 55% of the children in the age group of 11-14 and 35% of the children in the age group of 14-17. The others are in institutions of specialised nature or in colleges and universities. There are 4 universities, including the Indian Institute of Technology, which is "a deemed university," in the state and proposals for the starting of an Agricultural University have been accepted by the Government. The State spends about 23% of its budget on revenue account on education. Undoubtedly this is the major investment on our educational effort. However, this is supplemented by the efforts of private organisations which maintain and run many

educational institutions with the financial grants made available to them by Government.

2.3. It has been estimated that approximately 30% of the population in advanced countries is connected on a whole time basis with educational activity either as students, teachers, administrators or supporting staff. If we visualise the same degree of involvement with education in our State also, it may mean that about 15 million persons will form part of the educational effort — the large majority of them will undoubtedly be students. On a rough basis, therefore, there is justification for increasing our investment from the present level of 23% to at least 30% of the State budget under the revenue account. It must also be appreciated that this estimate almost doubles the figures for student population over the existing levels. Naturally, it will involve a doubling of all our resources and facilities available for education. It is in this context that it becomes imperative to tap the vast potential of support that can come for educational activity from the community rather than expect the State alone to accept the total responsibility.

3.1. Innovation is not new to the Indian Education scene. In the earlier part of this century leaders like Gandhiji, Tagore, Dr. Karve and others did significant work in an effort to evolve a meaningful pattern of education suited to our national genius and aspirations. Gandhiji was a staunch protagonist of what was known as 'basic education', the central philosophy of which was to learn through work—an essentially sound and tenable educational philosophy. It found wide acceptance in the flush of patriotic fervour of the pre-independence days. Its great bias towards manual labour and rejection of machinery and mechanisation was acceptable then. With the advent of freedom, there was an understandable clamour for quick transformation of our society by the rapid and extensive application of science and technology for rais-

ing the standard of living of all our people. This has raised serious doubts, in the minds of many, about the relevance of basic education, as preached and practiced by Gandhiji to our present day needs. The spread of basic education in the last two decades has thus not kept pace with the hopes and expectations raised earlier. On the other hand, there has been phenomenal expansion during this period in the conventional sphere of educational work.

3.2. In the early fifties, a suggestion was mooted and hotly debated in Madras, to the effect that the hours a young child spends in school should be drastically reduced to about 3 per day; so that the remaining time he may spend at home with his father; learning ancestral crafts and skills if the child was a boy and if the child was a girl, with the mother learning the household arts and skills. This again was a striking idea, in so far as it postulated that the schools should content themselves in providing the conventional knowledge in the three R-s and in general, be responsible for the liberal content in education whereas the practical skills needed for earning a livelihood will be imparted outside the school by those who practise these arts and possess such skills. The shortcoming of this plan was, of course, that it tended to perpetuate the inequalities in our society and appeared to from upon talented youngsters seeking to break away from tradition and reaching out for a better life or different profession than what was available to their fathers. It is on account of this that the scheme came under heavy criticism and never really got under way.

3.3. Generally, within the ambit of the existing pattern of schooling, other experiments have been made. One such was the introduction of the bifurcated courses in high school, offering a technical bias in their education to those who chose it. At the

same time, this did not close the doors for further higher education in different areas to those who felt that they had made a mistake earlier in high school in choosing to go in for a technical bias in their education. This is an experiment that has met with general approval and continues to provide a certain diversity in our otherwise monolithic educational structure. The establishment of a limited number of technical high schools as an experimental measure in the State, may be said to be an extension of this idea and an attempt to give a stronger vocational and technical bias to high school education. However, the response to technical high schools has generally been poorer than the response of students to bifurcated courses in conventional high schools in spite of the fact that technical high schools are much better equipped and staffed for instruction in engineering and technology. This may be because of the feeling that in a conventional high school, there is freedom of choice for a student either to take up the bifurcated course in engineering, agriculture or commerce, etc., or stay with the normal academic course, whereas in a technical high school only an engineering bias is provided. However, a student who has gone through a technical high school has no difficulty in pursuing higher academic education in non-engineering disciplines.

3.4. A significant step that was taken towards quality improvement, in general, in our secondary schools was the introduction of the so-called "god-father" scheme whereby a strong and well-established educational institution, generally a college, was expected to "adopt" a weaker secondary school, support it and help it to build up better curricula, teaching methods, laboratory equipment and teaching aids. The major weaknesses in our elementary and secondary schools, is the absence of adequate teaching aids and materials, as well as, standard equipment for experimentation

by students. It must be admitted that with a little imagination and guidance, it is possible indigenously and locally to fabricate many of these required items for use in a school. The essential thing is, of course, to ensure that such fabrication is attractive enough to encourage young people to make extensive use of such equipment. A shoddy piece of equipment attracts neither teachers nor students to utilise these as aids in the process of teaching and learning. If senior and experienced teachers in colleges would take an interest in advising and guiding the preparation of such materials, such materials would be properly designed, fabricated and utilised. Also, such cooperation between institutions at different levels of the educational pyramid leads to other beneficial results wherein the knowledge and experience of senior persons can be utilised for improving the curriculum content of elementary and high schools. It is thus that the so-called "god-father" scheme assumes very great importance in the quality improvement programme for education. This scheme should be implemented extensively and vigorously.

3.5. Another innovation made was the organisation, periodically, of the so-called school improvement conferences in which educational authorities got together with leaders of the community and discussed the problems and deficiencies in their schools. These conferences have brought an awareness of the educational problems and needs to the community which these schools serve and have encouraged the idea of public participation in the programme of improvement of these schools. Substantial contributions have been made by the public towards meeting the needs of essential equipment, buildings etc. as a result of these conferences. More than this, the awareness and interest created in the community about the quality of education available to the young, is in itself a very desirable feature of this programme.

3.6. Towards improvement of quality and competence of teachers, extensive programmes of in-service training, workshop for science teaching, refresher courses, etc. have been organised. For college teachers also, summer and winter school programmes have been conducted in various specialities, with the assistance of the University Grants Commission and other agencies. All these have brought specialised and modern knowledge, both of the subjects and techniques of instruction, to large numbers of teachers. The response from teachers to such programmes has generally been enthusiastic and one hopes that the results have been commensurate with the efforts that have gone into the organisation of such programmes.

3.7. In view of the widespread poverty in the country, large numbers of young children have either not enrolled in schools because of economic considerations that necessitate their staying at home and helping out with the family chores; or when they do enroll themselves in the schools, their nutritional levels are so low that they sit in a class-room with hungry stomachs unable to concentrate on what goes on. For our young people this is a very poor climate in which to acquire education or skills that they are seeking. Realising this, a scheme of providing mid-day meals to the school children has been evolved and implemented fairly extensively and with considerable success in Tamil Nadu. This one single measure has been undoubtedly responsible for creating a major change in the climate in our schools especially in backward poverty-stricken areas, of the State. It is a matter of satisfaction that substantial foreign assistance has been received for ensuring the success of this experiment of providing mid-day meals to poor children. In view of the large scale financial needs of this programme, public participation in this effort has been a distinctive feature of this scheme. More and

more people should take an active interest in the working of this scheme.

3.8. Mention must also be made of very substantial provisions made by Government for award of scholarships and loans to students particularly at the post matric stage (since education up to PUC is free in the state for all people); a keen and promising student need not end his academic pursuits, solely on the basis of lack of resources. In particular generous and extensive financial assistance is offered to backward and weaker sections of society that have been traditionally denied opportunities for education due to various sociological and economic reasons. In addition, free hostels have also been opened in several centres, thereby giving additional incentives for such sections of society to avail themselves of the educational facilities.

3.9. Very recently, action has also been taken to respond to the persistent clamour of working people for an opportunity for higher education at the University level. Several colleges have been permitted to organise and run evening colleges so that people who have been obliged to discontinue their education earlier due to economic compulsions are now in a position to continue their studies while they continue to be gainfully employed.

3.10. In the field of technical education, sandwich type of courses as well as part time diploma courses for working people have been tried out with considerable success for the past several years. The value of such courses is obtaining increasing recognition both from educators as well as employers. At present, we seem to be on the verge of large scale expansion of facilities for sandwich type of training as well as part-time courses for engineering students. Such courses will also be of value in certain other disciplines besides engineering, such as business management, social service, etc.

3.11. Women's education for technical professions such as engineering received a great fillip with the founding of women's Polytechnics in the State. At present 3 such institutions are working successfully at Madras, Coimbatore and Madurai; wherein girls are trained in various branches of engineering. Besides, provision is also made to offer institutions in other areas such as commercial and secretarial practice, etc.

4.1. At this stage, it will be worthwhile to recall some of the major problems in education to which we must pay attention. Any innovations made must be justified on the basis of their contribution to the solution of these problems, partially or fully. Besides, all action that is taken must be such as to further the objectives of the educational pattern that we place before ourselves. Advancement in the quality of life in this country and equality of opportunity for all its people for a better life must necessarily assume great importance in the scheme of things.

4.2 Persistent criticism has been levelled against our educational set up. The intensity of criticism has not greatly diminished in spite of the several significant reforms and changes introduced in our educational organisation. Reference will be made to some of the more frequently heard allegations about the inadequacy or deficiency of our system. This is not to say that all such criticism is wholly valid or entirely true but nonetheless when it is heard frequently there must be an attempt to examine it closely and dispassionately and take such remedial action as is needed.

4.3. The first criticism is the allegation that the matter and content of our educational programme is anti-deluvian, that no effort has been made to change this, no action taken to bring the syllabii and course contents up to date. The second is the poor and unimaginative personnel that we draw into our schools

and colleges as teachers; persons who have literally been failures everywhere else who take to teaching as a last resort. The position, it is alleged, is brought about by the poor financial rewards, absence of recognition of the vital tasks performed by these teachers. A third criticism is of our examination system which by and large is founded on a suspicion of everyone involved in the process of education. Also the system is a great tyranny on the mind and memory of the individual student and is no aid to the process of learning. There are alternatives that have been tried but these alternatives also have been criticised. Hence we have not been able to evolve a significantly different system of examinations from the one we have been used to for so long.

4.4. A very serious drawback of our present set up is that it is oriented towards the weakest amongst our young people of a certain age group. We stratify the youngsters into different age-groups and insist on their following a uniform learning pattern without making allowances for the brighter ones to proceed faster. This results in loss of interest and induces boredom with the whole process for the gifted few. It is often said that it is the gifted few who set the pace for a country's or society's advance and progress. If these are not actively helped and encouraged, if they are yoked to all the rest and not allowed to move faster, it is very unlikely that society as a whole will move faster.

4.5. Structural rigidity is a distinctive feature of our educational set up. There is also a great deal of emphasis on uniformity in structure content and achievement. Nearly 70 lakhs of students enrolled in our elementary and secondary schools have to go through a substantially *common* experience and study a common curriculum. The instruction is imparted by teachers who have little freedom to innovate, experiment, or alter the curriculum and avoid the deaden-

ing uniformity to which our children are subjected to year after year. If a radio set, or a slide or movie projector is to be acquired for the school, if other types of equipment are to be acquired for the laboratory, this can only be done on receipt of a circular specifying the make, cost and other details of equipment that can be purchased. Such a circular must issue from a central source thereby killing the initiative of the men on the spot. This also multiplies the bureaucratic set up with the attendant proliferation of files in which school headmasters and college principals are often buried. For the whole state we have a single board of secondary education. At higher levels of University education again the position is somewhat akin though not quite so acute. In academic matters only the central authority of a university has any initiative in framing curriculum, in conducting examinations and in determining what shall be taught and who shall teach it. This centralisation certainly ensures that minimum standards are maintained in all aspects of our educational effort—the attainment of students, the provision of physical facilities and the competence of teachers. But does it provide the incentive for improvement, higher levels of attainment and the freedom for individual growth and enterprise? I suspect that far too often it provides the alibi for those unwilling to exert themselves and strive for better results. In the more unfortunate cases, it penalises those that dare and show initiative and imagination.

4.6. With over 7 million young people in our schools and colleges and an almost equal additional number that will be there if we enforce compulsory education up to the age 16-17 years and take into consideration the growth of population in the next 10 years, we have on our hands a problem that is quite staggering even in terms of providing the basic physical facilities needed for educating such large numbers

of additional students. Admittedly we have serious limitations of financial resources. We also have problems with our human resources available for teaching and guiding the educational effort. School buildings, furniture, equipment in a large section of our schools and to a lesser extent even in our colleges could stand considerable improvement. At the same time additional accommodation, equipment and teachers have to be found to an order of magnitude equal to the present available resources if we are to bring into the ambit of the education effort all children at least up to the age of 17 years. Already education accounts for 23% of the total expenditure on the revenue account in the State Budget. So for the increased facilities that must be provided to ensure universal education up to the age of 17, there would be considerable strain in finding the resources from the State budget, with the result that progress can only be halting and painfully slow. We must minimise the total dependence of educational effort on finances provided by the State and encourage local community leadership to accept a greater share of these burdens.

4.7. The other aspect that we should not lose sight of at present is the changing pattern of Indian Society from a purely rural, agriculture-based one to an increasingly urban and industrial base. The demands for man-power with technical skills needed by the complex modern industrial society has increased considerably and will increase greatly in future. Up to now our techniques of measurements and estimate of the needs of various types of trained personnel have been made with inadequate or erroneous data and have quite often landed us in difficulties. The situation existing in the field of engineering for the past few years, with sizeable numbers of unemployed engineers, is a case in point. There are professions in which there is also a shortage of manpower with adequate degrees of skill. These imbalances arise also partly due to the fact

that a detailed study of manpower problems in a large country such as ours takes considerable time. It also takes appreciable time before we formulate remedial measures and implement these particularly since any changes we have to make affect large monolithic organisations with built-in inertia and resistance to change.

4.8. Though generally, we think only in terms of the young while we speak of educational problems, in the context of our country's development I would like to draw attention to the problem of adult education also. The need for adult education arises from two compelling factors. Firstly we have an adult population the over-whelming majority of which is illiterate. With improved medical and health facilities, the life expectancy has gone up steeply, as Prof. K. K. Pillay's paper last month highlighted. This means that this illiterate section of the population will be around for a long time though we may succeed in ushering in universal education amongst our young. We cannot afford to be complacent about this situation because only when we open the doors of education and enlightenment to this significant adult and mature section can we expect them to participate actively in the development of this country and thus hasten our growth. Secondly, the skills that our rural population, in particular, has acquired over the years is just becoming obsolete with the advent of science and technology. Availability of electricity in our villages, mechanisation of agriculture, modern transportation, etc., make demands for re-training our working population to meet to-day's needs. When we faced these problems in the past particularly as a result of social legislation we did nothing by way of conscious large scale educational effort to mitigate the hardships of the persons involved. What really happened to the toddy tappers on the introduction of prohibition?

What happened to our goldsmiths when gold control legislation was introduced? What is happening now to the sizeable numbers of repatriates from Ceylon, Burma and other countries, most of whom are being resettled in Tamil Nadu, who do not have opportunities for engaging in their traditional occupations now that they are in a new environment. Technology creates newer kinds of employment needing different kinds of skills; at the same time it causes obsolescence in many existing areas throwing people out of employment. The problem will be magnified as we become, a western type of technology oriented society. In that context adult education and re-education must necessarily be an important sector of our educational activity.

4.9. In a democratic society there must be active participation of the people in formulating the policies of education. However wise and enlightened, a handful of persons should not be in a position to decide on education policy without the opportunity for the people in general to have a say. A sure guarantee against the misuse of education for wrong ends by economic, religious or political authorities is to ensure that education is thoroughly decentralised and community or region based rather than nation or state based. It is true that in this country there is already a certain built-in safety because education is a State Subject and each state can use its own initiative and formulate its own plans for development in the manner it thinks best. But signs of such trends are not lacking. Safety, therefore, would lie in further decentralisation of educational efforts to the grass roots level of our people.

4.10. In today's world, media of mass communication have been exploited to an increasingly large degree. These reach and sway the minds of large masses of people bringing information and knowledge along with amusement and entertainment. Unlike the formal school structure, these media offer a great

deal more freedom and variety in the fare that is served. People find these easier to accept than the same fare served in the more traditional and disciplined sector of educational institutions. The cinema, radio (and TV) and newspapers have become powerful means of educating and enlightening our people. It is desirable that we find ways and means of incorporating these into the formal framework of education. They should be particularly suited for the liberal arts content of education like painting, music, etc. while at the same time serving as a powerful educational aid in other areas. To the extent such aid is taken from the media for educational purposes, we can afford to reorient our educational techniques to make it more exciting and acceptable to our young people.

5.1. Having touched upon, in general terms, some of the problems, it is perhaps appropriate now to consider some solutions that suggest themselves. To ensure structural flexibility and avoid the dangers of monotonous uniformity, secondary education in the state should not be the responsibility of a central authority as it is at present but that of a number of local School Boards or Districts that will have the freedom to act independently in the spheres of curriculum, planning, conduct of examinations and accreditation. The constitution of such boards must give equal weightage to three important sections, *viz.*: (1) the local public, (2) teaching fraternity and (3) the government. The responsibility of one such Board should not extend to anything beyond a 1,000,000 pupils in all. In other words, for the existing structure of one S.S.L.C. board we may substitute 7 autonomous boards with the proviso that as the student strength increases, new boards will be formed.

5.2. Since all the three elements in the Board will be interested in the maintenance of standards, there is no fear that such diffusion of authority will tend

to lower standards. On the other hand, the more compact group size will have certain beneficial results of closer supervision and quicker response from the Board to local problems and needs, and of a greater and more personal interest in improving the quality of the educational service offered. These Boards will also be able to excite more local interest for supporting such worthwhile activities as better buildings and equipment for schools, midday meals, school uniforms and books and equipment for the children so that the resources of the government could be conserved for other essential developmental activities.

5.3. Such Boards of education should have overall responsibility for all education up to the secondary education level including vocational and craft education; adult literacy and retraining programmes. The responsibility should not be for direct involvement in the management of schools and institutions but only to lay down educational policies: plan and organise the general content of education, organise and carry out evaluation and examinations and ensure that individual institutions accredited to the Board do maintain appropriate scholastic standards and initiate, where necessary, all such programmes of quality and quantity improvement, as may be necessary.

5.4. At the level of post-secondary education, somewhat the same objectives could be achieved by encouraging the emergence of smaller and autonomous units for teaching, leaving the university as a centre for post-graduate research work and advanced teaching. The emergence of autonomous colleges as single independent entities, or groups of colleges in reasonably close physical proximity forming an autonomous unit (college clusters) will obviate the feeling amongst many college teachers that they are merely teaching machines without any responsibility for determining either the quantum or content of what is taught. By transferring the authority for

evaluation of student performance also to the College, examinations will have a direct bearing on the instruction imparted and be thus more meaningful in that they will provide the necessary information as feed-back to enable the teacher to examine critically the effectiveness of his teaching. At any rate, there will obviously be a great deal of more freedom for changing quickly the curriculum, based on the needs of the situation, as also for experimenting with different methods of instruction and examinations. The proliferation of predigested notes, as exists at present, and the total reliance on learning by role by the students also will be considerably reduced. More than anything else, by placing these responsibilities squarely on the teacher, one would be telling him that he is performing a very vital and independent function; that he is considered worthy and competent to do so. This should go a considerable way in reassuring the university teacher that he has an importance and status that are recognised in the educational and social system. It is responsibility such as this that makes people respond by working harder and dedicatedly and striving for better performance. There will then be a sure if imperceptible change for the better in the quality of our education because the teacher feels personally responsible. Teachers can then not afford to seek protection in their anonymity in a large organisation like the university, disclaiming any responsibility for the various ills of the educational system.

5.5. Where autonomous college clusters can be organised, attempts at co-operative teaching can also be attempted by utilising specialist teachers in common and also certain specialised laboratory and other facilities in common as between the different units of the cluster. Besides, such an arrangement will lead to fuller utilisation of the facilities provided by individual units and greater diversity of choice of

subjects of study, if student exchange between units is also permitted.

5.6. With the responsibility for updating and modernising the curriculum, for organising and carrying through of evaluation and examination completely in the hands of the respective autonomous colleges or college clusters, we may expect a general improvement in educational standards. With the general educational attainment rising to a higher plateau in this fashion, it is necessary to devote some attention to creating certain peaks of academic excellence on this plateau. This will largely be the responsibility of universities and more especially the functional universities. There should be at least one university in the State for each of the major applied sciences. The starting of an agricultural university in the state has become an accepted fact very recently. Similarly it is desirable that there should be a technical university and also a university of mechanical sciences. These should be single unitary campus institutions and not be of the affiliating type, so as to avoid the difficulties pointed out earlier. These functional universities may be developed from one of the major existing colleges in the same manner as it is proposed to develop the university of Agricultural Sciences from the existing Agricultural College. Apart from creating a centre of advanced learning in the major area for which it is responsible, such universities must also take up the development of all other disciplines which have a relevance to the major area of work in the university.

5.7. The management of all the institutions of university level education should be independent and autonomous. This may be achieved by constituting Boards of management in which representation should be given to teachers, students, local public and government say in the ratio of 40:10:25:25. Such autonomy, of course, will be subject to the over-

all government policy for ensuring social justice and equality of opportunity.

5.8. The demand for higher education is bound to increase greatly in future. This will also happen in the case of many who for economic and various other reasons were not able to pursue their education in colleges earlier but had to go into employment. To cater to such persons in particular, the provision of evening and morning colleges should be more extensive. Beside all the universities may organise correspondence courses for the benefit of working people in certain useful and practice disciplines which do not require elaborate laboratory practical work.

5.9. A major contributory factor for excellence in our educational programme is necessarily the teaching staff of institutions. A dedicated and well qualified staff is an essential requirement especially at the earlier stages of the educational scheme. No one should be accredited as a teacher, even for elementary schools, unless he or she has at least a university degree and a teacher's diploma so far as elementary and secondary schools are concerned. In fact a Master's degree should be expected as the desired qualification for all high school teachers. For University teaching a Master's degree should be the minimum with a Ph.D. as a desirable qualification.

5.10. Many well qualified staff once they commence teaching, tend to lean back on their past achievements and academic work and coast along without making conscious efforts to keep abreast of modern knowledge and teaching methods. In order to avoid the harmful effects of such complacency, and also the tendency to build up an insular attitude, every teacher should compulsorily be sent away from his own institution after each period of say 7 years service for a period of at least, one year, either to study, work, do research in some other institution, industry, business or university. In the case of some teachers, this period could

also be utilised for writing of books, etc. This proviso, of course, need not be literally enforced in all cases especially where a teacher heads a significant research group and where his absence for a relatively long period like one year may lead to stagnation in the work of the entire group. Such persons would be constantly exposed to the work and activities of their colleagues elsewhere and there is no danger or intellectual stagnation.

5.11. A large majority of our 31,000 odd elementary schools are housed poorly in totally unsuitable buildings with poor ventilation and sanitary facilities. To attract and keep children in schools, the facilities provided must be good not only for studies but also for play. Massive investment is called for to modernise our facilities. Similarly the secondary schools require a great deal of attention particularly the laboratory facilities. With decentralisation of control and management of institutions vesting with local bodies or private managements, the enthusiasm of the local people must be harnessed to modernise and upgrade all schools and their equipment. At present there is a tendency on the part of people to petition the government for all their needs and wait for the government to initiate every item of improvement or development work. This mentality must be challenged and changed; only then can we expect a constant awareness on the part of our citizenry of its obligations to provide good education to the younger generation.

5.12. The financial burdens of running educational institutions have been greatly lightened by the government grants-in-aid that cover the major portion of such expenditure. Private managements have not generally felt the necessity for soliciting public support and participation in sharing the financial and management burdens of running institutions founded by them. Institutions operated by local bodies like

panchayats finance their operation out of government subsidies and a local education cess that they are authorised to collect. Voluntary financial support of the general public for the upkeep of such institutions is seldom sought or obtained. Even alumni seldom consider it an obligation to contribute to the financial support of their former schools. An inevitable result of such unconcern is that none of these important sections of our society show any interest to what happens in our schools. This is in contrast to the situation that exists in USA., for example, where privately run institutions rely so heavily on community and alumni support. They do not normally get any grants from government—state or Federal. Partly to encourage local interest and effort and partly to conserve government resources for other development activity, it would be good if we were to accept as an ultimate objective that the system of grants-in-aid to educational institutions will be given up after a specified period by which time all institutions must arrange to build up needed endowment resources for their normal working by raising funds on their own from alumni, the community or charitable foundations in the country.

5.13. Sudden withdrawal of financial support even over a 10 year period by government from institutions that have been traditionally dependent on such support will undoubtedly create confusion. Also the frantic scramble for soliciting support, from all and sundry, to build up quickly a sizeable endowment is likely to create pressures and tensions not conducive to the healthy growth of these institutions. The principle if accepted at all, must be tried out in a phased programme over a limited region or section of the educational complex, to start with. At the same time the government could provide incentives and aid in the furthering of the scheme either by (1) promising for ten years a matching grant over and above the

normal grants, for all funds raised by the institution towards its endowment or (2) by giving each year, for the next ten years, an amount equal to the annual grant to be added to the endowment of the college. Necessary safeguards will have to be provided to ensure that no management of any of the institutions depletes the capital of the endowment fund but operates only on the income derived therefrom. It might well be asked why education, which is a basic responsibility of the state as we understand it, should be deprived of direct financial subvention by the State. The main reason for suggesting such a procedure is based on the realisation that after all men's minds are conditioned to a great extent and are susceptible to indoctrination during the youthful formative years when they are being educated. If education is controlled totally and made into a state activity, there is always the danger that the State could misuse its stranglehold on a very vital sector of our social life. If the people must retain in their hands ultimately the right to choose freely the kind of governmental organisation they wish to have for themselves, the basic need will be, for them, to present the educational system from being controlled or corrupted by current sources of political power to present economic, political or religious attitudes. The freedom of access to information and knowledge is a thing that must be zealously guarded.

5.14. Education up to the secondary school stage should be compulsory and free as it is at present. The aspect of compulsion must be enforced with greater care, thereby increasing substantially the enrolment in our schools and ensuring that we are not adding substantially to our army of illiterates. I would suggest a levy of a fees of Rs.2/- per year per child to be collected by each school and credited to the account of the Local School Board, thus getting an income of Rs.14 lakhs. Of this, a sum of Rs.2 lakhs may be set aside for two prizes of Rs.1 lakh each to be awarded, one to the best primary school and another

to the best secondary school in that school district on the basis of their academic and extracurricular record, on the community participation in the working of the school, on leadership it has shown in the matter of improved educational patterns of work etc. So as not to reward the same schools year after year, once a school wins such an award, it may not be considered for the award for 5 more years. Any school winning such an award will have the prize money added to the corpus of its endowment. A further sum of Rs. 50,000 may be annually awarded to any school that has contributed most towards the development of the community in its neighbourhood. This award will be utilised by the school for the organisation and improvement of its library so that it will also be accessible to the public as well. Equitable distribution of this award on a geographical basis year after year must be ensured.

A fourth award of Rs. 50,000 should be a grant for any school which comes forward to organise an educational and science exhibition. The amount is to be utilised partially to enable all children belonging to that school district to see the exhibition as well.

The remaining 11 lakhs of rupees will be utilised by the school board to give matching grants to all institutions who may have raised resources for permanent endowment or immediate needs such as buildings for class-rooms, development of play facilities, provision of school requisites and uniforms, midday meals or support to teachers' families in distress. Any unspent sum at the end of the year will remain as a permanent fund with the board so that its interest could be further utilised for the establishment, of a central production shop cum repair facilities wherein simple equipment needed by schools could be fabricated and supplied at cost or repairs of instruments and equipment in the schools could be undertaken at nominal cost. The

purpose of this special fund of Rs. 14 lakhs per year raised from the students in the school district is basically to serve as a catalyst for action; to create a lively and eager spirit of competition from the school authorities in the matter of making their respective schools living organisms that need to grow if they are at all to survive. It is hoped that the sizeable financial rewards given in recognition of outstanding achievement would spur them to work hard to achieve the distinction of winning such rewards.

5.15. The problem of dropouts from our schools is staggering. Within the just five years of schooling over 40% of those enrolled drop out. This cannot be entirely due to financial reasons. To avoid this wastage, along with the introduction of the element of compulsion that will keep all children in school up to the age of 16, we must make special provision of school hours for children who must work at home or in the field and for those who are not able to keep up with the academic programme. This latter may be in the form of special institutions with technological bias such as technical high schools etc. duly taking note of the aptitudes and inclinations of the student himself.

5.16. Similarly, for the benefit of working persons, housewives etc., craft instruction schools must be organised on an extensive basis. These schools may have special working hours to suit the convenience of those for whose benefit these courses are organised. In organising such craft courses, the needs of the particular region and the appropriateness of starting certain courses, should be carefully examined. On the other hand, there are certain craft courses like doll making, painting, dressmaking etc. which will have a universal appeal to women in particular in whichever part of the country they live in. Generally, such courses should be organised on a self-supporting basis and suitable training fees should be charged.

5.17. In the above brief review it has not been possible to detail many different directions in which to make desirable changes in our education pattern. This is because of the belief that our educational complex, containing a very large body of enlightened intelligent people who are capable of contributing significantly to the improvements we are seeking. My main theme is that this vast potential of intelligence and resource is lying dormant and not fully exploited because of a prevailing belief that all innovation or action oriented programmes must originate from the sources of political and economic power. This is to my mind a great tragedy. That is why I feel the main innovation in education must be in decentralising it; in giving the reins of command where it should really be: in the hands of those who are engaged actively in the educational process *viz.*, the teachers themselves. It is necessary that the community must realise the place and importance of the teachers in the scheme of things and give them the moral and material support needed to ensure to our children the best of modern education that will enable them to seek and live a better and happier life.

SCIENCE AND NATIONAL DEVELOPMENT

(*Extracts from the address by Dr. Malcolm S. Adiseshiah on the occasion of the ninth Anniversary of the Institute of Mathematical Science, Madras, 13th January* 1971)

As we meet once more to participate in this annual gathering of the Institute, it is well that we remind ourselves of the truth that science is the scientist. It begins with him and flowers and flourishes as he is allowed to flower and flourish. On this occasion we are commemorating another great scientist of this land. Homi Bhaba, with whose passing our first generation of scientific giants has passed. The most recent loss that we have suffered in this scientific honour list is that of C. V. Raman who also joins the roll call which

includes Birbal Sahni, Jagdish Chandra Bose, Ramanujam, Shanti Swarup Bhatnagar and K. Krishnan.

This roll call of Indian Science is more than a reminder of our immediate scientific heritage. It is even more an important comment of the scarcity value of this our resource. I wonder how many realise that 90 per cent of all scientists who have lived in our world are living today in our times and that 90 per cent of this number are living and working in the industrially advanced countries of Euro-America. It is within the remaining 10 per cent of scientists in the third world, that we in India possess this rather large and impressive scientific talent. And so we have a solemn national and international obligation with regard to this wealth that we possess.

Indian Science and Indian Development

This obligation is perhaps simply and somewhat platitudinously expressed in statements which refer to the contribution that science makes to national development. At the annual Science Congress in Bangalore held at the beginning of the year, this relationship was once more stressed with urgency. In his presidential address Dr. B. P. Pal, Director General of the Indian Council of Agricultural Research, calls attention to our neglect of the agricultural sciences. A great deal of intensive research is needed for our unirrigated dry farming areas which cover 80 per cent of the total cropped area of 133 million hectares. The high yielding varieties which are a natural source of pride and satisfaction to all of us not only cover just five food crops—rice, wheat, sorghum, millet and maize; the research which produced this green revolution was undertaken largely outside India, in Mexico city, in Los Banos in the Philippines and in Tokyo in Japan, by non Indian scientists. Awaiting scientific attention and research by our scientists are pulses, oilseeds, cotton and jute fibres, fruits and vegetables, in fact, the whole gamut of

plant science, which needs to be given pride of place in our scheme of scientific priorities. Similarly further scientific inputs are urgently needed to promote and generalise multiple cropping, animal husbandry and fisheries, in which our scientists have not as yet made an adequate start.

Such are the vistas that are open to our science and scientist in relation to national development. But these vistas are not new. Year after year at our science congresses we seem to be bemoaning the lack of a close and adequate nexus between our science and our development. Our priority is clear,—the agricultural sector and the demands for development of our stagnant and sluggish country side. Why is there then this gap between our scientific potential and the priority demands of our national development?

Scientist's Task

Is it because we have got our priorities in science wrong? Are we developing a society in which the scientist is more at home in planning, co-ordinating, managing and administering what others are doing rather than in pushing patiently forward the frontiers of knowledge and applying our technology to the practical and urgent problems that are crying aloud for alleviate action. Dr. Atma Ram, the Director-General of the Council of Scientific and Industrial Research seems to think so. In his anniversary address to the Indian National Science Academy he refers to the barren new elite emerging in Indian Science. He attributes the topsy turvy nature of our priorities to this rise of a new bourgeois class of scientists in the country who have had no experience of research but who nevertheless have got into decision making positions as far as science is concerned. Whether or not we agree with his harsh comment, I believe that all of us here and elsewhere will agree with his gentle admonition that there is no substitute to good and plodding scientific work by the

scientist in his laboratory or bench and it is such work by dedicated scientists which makes for economic growth and scientific edification.

This kind of blunt stocktaking is salutary because the stakes at issue are great. They are no less than the welfare of our people and the country's economic growth which is the base for its well being. The role of science and technology in causing and promoting economic growth is widely and generally accepted. In fact in our modern industrial societies, science has become synonymous, with the development process itself, and is an autonomous sector within the economy. We are all used to the traditional classification of the economy into primary, secondary and tertiary. Today, Science has emerged as a quarternary sector with 20—25% of the total labour force of the post industrial societies employed in it. We in India are not there as yet—not by a long chalk. But with our plethora of scientists and with our not unimpressive scientific heritage, we should ask ourselves the question—are we today wasting our scientific sustenance? If we are, then we need to turn right around and correct ourselves. We can take such corrective action, for after all that is what science is all about—the facing and analysis of facts, the rule of reason and the pursuit and application of truth as we see it.

Science as the Instrument of Development

Science and technology have a double development function—as the instrument of development on the one hand and as the cause of development on the other.

Science and technology are a tool of development. They are instruments with which political leaders and planners obtain specific and practical answers to the intricate and intractable development problems that they are facing. I have referred to some of our urgent problems of development—those of the small

farmer, the dry farmer and the farmers living and toiling in the traditionally draught stricken areas, all of whom constitute the overwhelming majority of our people. To these demands must be added the problems of import substitution particularly with regard to many of the needed capital goods, involving methods both of producing known machines as well as developing new ones. A further problem that we shall soon be facing in Tamil Nadu is in the area of water. We have now harnessed all our rivers for irrigation, hydel and hydro-electric purposes. Our supply position is therefore critical and we need a water policy based on the intensive and coordinated work of our hydrologists.

Science as the Cause of Development

There is of course the broader role of science as a driving force of development. Here development is a function of the work of scientists, engineers, and technicians who by advancing knowledge, inventing new processes and improving existing techniques are creating new possibilities and opening up new horizons. It is in this way that science provides the bases of material progress and shapes future economic and social structures. Thus science emerges as the cause of development.

Basic Sciences

Both aspects of science, the instrumental and the causal, have a common infra-structure, namely, the development of basic sciences. It is appropriate that we pay some attention to this vital aspect of our national life. Modern technology, applied science and development research which have produced variously the computor revolution, the vistas of unlimited water resources through desalinisation and the break throughs that I have referred to in world food supplies are all an outgrowth of basic science studies and the pursuit of fundamental research. We readily

equate basic sciences with the light giving aspect of knowledge. That is right, but basic sciences are also fruit bearing. This was underlined by the third OECD ministerial meeting on science which declared: "In addition to its intrinsic importance, fundamental research is one of the keys to innovation in the research intensive industries. A short-sighted view of the significance of fundamental research may endanger the future development of a host of other activities of a more applied nature." That is also the experience of Unesco.

Is it this combined light bearing and fruit giving aspect of basic science that accounts for the fact that the United States in the years 1958 — 65 increased its fundamental research expenditures at 17% annually which was twice the growth rate of all its R and D activity? In the confusion and limited progress in our population control programmes traceable to a lack in the necessary basic biology research? Is our inability to apply existing knowledge, adapt the results of research obtained elsewhere to our own conditions, our slow progress in the modernisation of agriculture and the halting development of intermediate forms of technology due to our inadequate infra-structure of basic science teaching and research?

Such an infra-structure is an indispensable modernising factor for the improvement of the social and organisational basis of all developing societies, by introducing what I would call scientific literacy, by invoking rationality in the climate of business and by combating invincible ignorance in matters of science which seem to characterise all administrations. My studies show that there is a close co-relation between research expenditures and GNP growth which can be expressed as a I : 3 ratio in relative and I : 5 ratio in absolute terms.

Use of Science

But the relationship of science to development makes a double call on the scientist. He is expected

to produce science. He is also called upon to take some responsibility for its use. Mrs. Gandhi, our Prime Minister in inaugurating the Indian Science Congress the other day devoted her address almost exclusively to this latter call on scientists. She asks our scientists to shoulder the responsibility of promoting a temper of tolerance and a respect for facts. The call that is being made today on scientists is not only for the advancing of knowledge, for invention and discovery, for seeking and searching. They are also being asked to undertake a number of other, apparently non-scientific tasks. They are asked to help conserve the biosphere not just to exploit it. They are being asked to help maintain human values including traditional mores and not ignore them as unscientific. They are being asked to place man and his well-being at the centre and as the objective of their investigations, not simply as their subject and instrument. They are asked to bring to bear the flexibility of varying personalities to their common task and not a monolithic unidimentional discipline. In other words the scientist is being asked not only to produce science but to ensure its proper and human use — for man and the well being of man.

I would like to illustrate this extra scientific demand on the scientist with three current situations:

The first refers to the problems that man faces in relation to the biosphere. Writing in his usual whimsical manner John Kenneth Galbraith in the *Affluent Society* portrays the crisis in his society. "The family takes its mauve and cerise airconditioned, power-steered and power-braked automobile out for a tour passes through cities that are badly paved, made hideous by litter, blighted buildings, bill boards, posts for wires that should long since have been put underground. They pass on into a countryside that has been rendered invisible by commercial art. They picnic on exquisitely packaged food from a portable ice-box by a polluted stream and go on to spend the

night at a park which is a menace to public health and morals. Just before dozing off on an air-mattress beneath a nylon tent, amid the stench of decaying refuse, they may reflect vaguely on the curious unevenness of their blessings." They need no longer indulge in such vague reflections. There is today a general revolt against the social maladjustments and distortions which the unplanned and somewhat self centred use of science has brought out into the open.

A second illustration of the extra scientific demand on scientists is the trend in the industrialised countries away from specialisation in science and technology. I came upon this interesting fact when studying the causes for student revolt and youth unrest which reached their high point in the Spring of 1968. The Dainton Committee reporting in January 1968, called attention to the swing away from the study of science and technology in British Universities. Admissions into science and technology in the United Kingdom declined from 45.9% of the total admissions in 1962 to 40.6% in 1966, while the rapid growth in the social studies was marked by the upswing from II.9 to 22.5% A similar movement away from science and technology to the humanities and social studies is reported by the universities in the United States, Australia and other European countries. There are specific educational reasons for this declining interest such as the too narrow and too specialised secondary science base, the poor methods and materials in science teaching, etc. But the social frustrations and contradictions caused by the use of science are a major factor. Science has produced the computor, the laser, nuclear fission and its use for bigger and better nuclear weapons and cleaner and neater atomic triggers and arms, the faster than sound jet and the rocket and space exploration. Meanwhile all around us there continues with increasing force and clamour the sadness, the sickness, the wasteage, the muddle, the poverty inequality and injustice which seem to have little or no relation to

the marvels of science. The social sciences and humanities at least point to the social dangers and are engaged in social analysis. Is it surprising then that the finest and most alert minds in our universities in the industrialised countries are turning away from Natural Science?

My third situation refers to the insistent demand made on the scientist, who has given man such terrible weapons of self-destruction, and who is now called upon to give man also the power to control the source of these weapons. Writing in a book, *Let My Country Awake*, published by Unesco last year as I was leaving the Organisation, I said: "Peace if it is to be attained must also be purchased. We are after all purchasing war at the price of unaccounted billions of dollars of our study, research and development in so far as we remain indifferent to the use of their results. We are preparing for war preparedness, whatever that may mean, at a further annual additional colossal cost of 200,000 million dollars. Are we willing to pay the price to purchase peace? Are we willing to assume responsibility for the use to which our knowledge, our inventions and discoveries are put and help forge the necessary instruments of control over their use?"

It is against this kind of background that the Indian Science Congress's inaugural call resounds with relevance and insistence. It is a call for the scientist in India to bear in mind the welfare of the people of the country, to help in maintaining human values and to promote the qualities of truth and tolerance. I know that this may seem to some an intolerable burden on the scientist. He is being asked not only to produce science but produce human and socially viable science. I know that some of my scientific friends in India and abroad will feel that this baring of the pure flame of science to the fitful and erratic winds of society and humanity is futile and unproductive, both to science and society. What the

scientist knows is science and that is what he should limit himself to. Its cultural precondition and social application is the concern of the non scientists, the administrator, the politician, and the humanist. How I wish this separation was realistic? The scientist not only splits the atom in his laboratory but makes the bomb and is now perfecting the clean bomb. He not only discovers micro organisms, he also produces the horrible biological weapons. In truth, however, I must point out that there are two uses of science: for one the scientist is responsible and for the other he has no direct responsibility. He invents the chemical agents and gases but also turns them into an effective defolient. He is not responsible for the further decision to use them against a given country. But the real mischief is the first use of science for which he is responsible. Once he produces the Atom bomb or toxic defoliants, to expect their non-use is like pulling one finger into a snake pit and calling on the grace of God to save one. In fact, attempts to separate science and its application takes me back to the early days of Unesco when a distinguished scientist who was Director of a department drew up an excellent programme for that year 1946 which he estimated would cost 50,000. When Unesco's budget director after reviewing and approving the programme asked: "Professor, do you mean 50,000 dollars, or 50,000 pounds, or 50,000 franks? The reply of the Scientist was: "But that is a purely administrative matter and is of no interest to me. My programme needs 50,000."

Four Demands on Indian Science

Such being the panorama of science and its complex of contributions to development, I want to end with four practical conclusions for us here in India.

First, at the primary and secondary school level, in adult literacy and extension programmes, the scientific spirit must be implanted. All development is endogenous and springs from the country's own people

and its culture. This implantation of science in our culture can be undertaken through what is to-day called integrated science learning, where the sciences are integrated around pressing local problems and not taught separately and theoretically as disciplines. This urgently needed reform of our science teaching and learning at the grass roots' level must be undertaken quickly. Unesco and Unicef have launched an 8 million dollar co-operative effort in India for this purpose.

Second, science learning and basic research must be modernised and intensified at the university and university type institutions. It is here that the basic science infra-structure of our country is being built. This calls for reform of science syllabi in our institutions of higher learning, an adequate system of selection of students who are our scientists of tomorrow, and the cultivation of the proper scientific research atmosphere in the Faculties and Departments. In regard to science at this level, the problem-oriented inter disciplinary approach centred around the phenomenological sciences is now taking over the purely disciplinary specialisations. At least some of our higher education and research institutons such as this Institute and the IITs are and should be moving in this direction.

Third, there is the call to our applied research and R and D activities which are centred in our national laboratories and in our very few private sector undertakings. Here the call is not only for intensifying the applied and developmental research work of these institutes but even more for forging the missing links between our science and technology, and our technology and our industrial and agricultural production. Given its scale of production and its dispersion and fragmentation, I see a strong case for growing state involvement in applied and developmental agricultural research. In the industrial sector, we have for over three decades been seeking to forge close links

between our developmental research and our industry. In my view these missing links will be forged only when the private sector assumes a much larger share than at present of the R and D work that the country's development demands. In Germany, U.K. and Japan 60 to 70% of R and D is undertaken by the private sector. In India where the private sector in manufacturing is relatively as important, its share of R and D is less than 10 per cent being in fact 5 to 6%.

Finally there is the problem of policy and priorities in our scientific research. Here we have at present various councils co-ordinating and directing research activities in industrial, agricultural, medical, atomic social and human sciences. Over all these Councils is the cabinet committee on science and technology (COST). We are at present discussing other alternative structures for advising on policy and deciding on priorities. It is well to bear in mind that there is no single ideal structure for co-ordinating and directing science. Structures are only instruments. What is essential is (a) for the scientist to have the right atmosphere and incentive to do his research (b) for his research to be related to the country's development needs in agriculture, industry, health, communications etc. For this there must be the closest link between the science bodies and the development authorities at all levels, central, state and local. There seems to be some lack in this regard and it is to removing these lacks that we should turn our attention.

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